VACUUM CONTAINER SYSTEM AND RELATED METHOD

FIELD OF THE INVENTION

[0001] The present invention relates to apparatus and systems for transferring material into a bulk bag using a vacuum, and especially to pump or vacuum systems configured for transferring liquid, particulate or slurry materials into bulk bag containers for transport, storage, disposal and/or de-watering.

SUMMARY OF THE INVENTION

[0002] The present invention enables the facile placement of solid particulate, liquid or slurried materials into bulk bags configured for commercial-scale operations which could range from volumes smaller than one cubic meter to volumes of 5, 10, 20 and over 30 cubic meters, depending upon the application, size of containers and other equipment, weight restrictions and the like. Various commercial settings require the placement of material into a substantially nonporous, flexible bag in order to facilitate the transportation, storage or disposal of the material involved. The material involved can vary widely from non-hazardous, non-toxic materials such as, e.g., grain, vegetable and other food products, particulate insulation material, to hazardous or toxic materials such as, e.g., paint or other chemical or petrochemical pit slurries, waste treatment pond dredgings or liquids, and the like. The present invention provides a system which enables the repeated and rapid placement of such materials into a disposable or reusable bag configured to retain the material so that an outer vacuum container employed within the system can be reused for subsequent loadings without the inconvenience or cost of significant cleaning procedures in between loads.

[0003] Thus, in one embodiment of this invention is provided apparatus comprising (a) a substantially rigid container defining at least one inlet port and at least one outlet port, and being sized and configured to define a first volume for receiving a liquid, solid particulate or slurry material; (b) flexible, substantially non-porous bag which forms a bag opening perimeter in sealed attachment to the container at the inlet port and being in an initial deflated state; and (c) a vacuum pump in fluid communication with the rigid container through said outlet port, wherein during operation of the vacuum pump, a vacuum is created within the rigid container to thereby cause the bag in an initial deflated state to expand and form a vacuum within the bag to draw material through the inlet port and into the bag.

[0004] In another embodiment of the invention, there is provided apparatus comprising (a) a substantially rigid container defining at least one inlet port, at least one outlet port and at least one sealable bladder port, and being sized and configured to define a first volume for receiving a liquid, solid particulate or slurry material; (b) a flexible, substantially porous bag which forms a bag opening perimeter in sealed attachment to the container at the inlet port and being in an initial deflated state; and (c) a vacuum pump in fluid communication with the rigid container through said outlet port, wherein during operation of the vacuum pump, a vacuum is created within the rigid container to thereby cause the bag in an initial deflated state to expand and form a vacuum within the bag to draw material through the inlet port and into the bag. This embodiment enables, amongst other things, the facile de-watering of slurried solids. When a bladder is placed across the bladder port and the port is open to the atmosphere outside the container, and when the inlet is closed during operation of the vacuum pump, even greater amounts of liquid can be removed from the slurry material within the bag, enabling for example the efficient de-watering of solids in the original slurry.

[0005] In yet another embodiment of this invention, there is provided a method which comprises (a) forming a vacuum in a substantially rigid container, which rigid container defines at least one inlet port and at least one outlet port, is sized and configured to define a first volume for receiving a liquid, solid particulate or slurry material, and includes a flexible, substantially non-porous bag which forms a bag opening perimeter in sealed attachment to the container at the inlet port, the bag being in an initial deflated state prior to vacuum formation, and (b) placing the bag interior volume in fluid communication with the liquid, solid particulate or slurry material through the inlet port so that, when the vacuum of step (a) is formed, the liquid, solid particulate or slurry material is suctioned into the bag when the vacuum of step (a) is formed in the container.

[0006] Still another embodiment of the invention provides a method comprising (a) forming a vacuum in a substantially rigid container, which rigid container defines at least one inlet port, at least one outlet port and at least one sealable bladder port, is sized and configured to define a first volume for receiving a liquid, solid particulate or slurry material, and includes a flexible, substantially porous bag which forms a bag opening perimeter in sealed attachment to the

container at the inlet port, the bag being in an initial deflated state prior to vacuum formation, and (b) placing the bag interior volume in fluid communication with the liquid, solid particulate or slurry material through the inlet port so that, when the vacuum of step (a) is formed, the liquid, solid particulate or slurry material is suctioned into the bag when the vacuum of step (a) is formed in the container.

[0007] These and other embodiments, objects, advantages, and features of this invention will now become apparent from the following description, accompanying drawings and appended, non-limiting, exemplary claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Figure 1 is a perspective view of a rigid container in an embodiment of this invention.

[0009] Fig. 2 is a perspective view of a bulk bag in an embodiment of this invention.

[0010] Fig. 3 is a side view in cross section illustrating the embodiment of Figs. 1 and 2 during use to move material into the bulk bag of Fig. 2.

[0011] Fig. 4 is a side view in cross section similar to that of Fig. 3, but illustrating an embodiment of this invention for removing liquid from a slurry material placed in a liquid permeable bulk bag within a rigid container in accordance with this invention.

[0012] Fig. 5 is a view similar to that of Fig. 4, showing the system of Fig. 4 during operation to remove a liquid from the material within the bulk bag.

[0013] In each of the above figures, like numerals or letters are used to refer to like or functionally like parts among the several figures.

DETAILED DESCRIPTION OF THE INVENTION

[0014] The accompany figures illustrate preferred embodiments of this invention. Fig. 1 illustrates a rigid container **10** for use in a preferred apparatus of this invention. Container **10** provides an inlet port **12** and an outlet port **14**, a first secondary port **11** and a second secondary port **13**. Container **10** is sized and configured to define a first volume **V** for receiving a liquid, solid particulate or slurry material. During typical use of the apparatus, inlet port **12** is in fluid communication with a suction pipe **15** (Fig. 3). The apparatus of Fig. 1 can be used with a flexible, substantially non-porous bag **16** (see Fig. 2) which forms a bag opening perimeter **18** for sealed attachment to container **10** at inlet port **12**. As illustrated in Figs. 2 and 3, bag **16** is

in an initial deflated state prior to installation in container **10**. As further illustrated in Fig. 3, the apparatus further includes a jet pump **P** in fluid communication with container **10** through outlet port **14**. During operation of pump **P**, a vacuum is created within container **10** to thereby cause bag **16** to expand and form a vacuum within bag **16**, which causes material to be drawn through the suction pipe **15** and inlet port **12** into bag **16**. While not required, it is particularly preferred that the free end (not shown) of suction pipe **15** be completely immersed in the material to be suctioned so that the amount of air allowed to enter suction pipe **15** is minimized.

[0015] Although not necessarily shown in the drawings, it is particularly preferred that ports **11** and **13** be as close to the bottom of container **10** as possible so that these ports may be conveniently used to empty container **10** of substantially all of its contents, especially standing liquids, as necessary.

[0016] As seen from the preferred embodiment of this invention illustrated in Figures 4 and 5, the apparatus can also employ a flexible, substantially porous bag **17** to thereby enable liquids in the material brought into bag **17** to be separated from the slurry to thereby filter the solids and permit removal of the separated liquids from container **10**. In particular, container **10** may be placed in f luid communication with and intermediate liquid tank **T** through a conduct **C**, tank **T** in turn being in fluid communication with vacuum jet pump **P**. In this particular embodiment, it is preferred that the vacuum connection to container **10** be made at port **13** (rather than port **14** as shown in the embodiment of Figs. 1-3), to facilitate removal of liquids from container **10** during operation of pump **P**. Operation of pump **P** to create sufficient vacuum causes slurry material to enter bag **17** and draws liquids through the pores in bag **17** to separate the liquids from the solids, and to draw the liquids into tank **T**. If even further liquid removal from the contents of bag **17** is desired, this embodiment provides a way to accomplish the same. While container **10** is substantially sealed at outlet **14** (and inlet **12**) and port **11** but in fluid communication with tank **T** via conduct **C** and secondary port **13**, a man way cover **30** may be opened, the opening constituting the bladder port across which may be placed a substantially non-porous bladder **B** so that, when in place and when man way cover **30** is substantially shut but a valve (not shown) at cover **30** is opened to the surrounding atmosphere, operation of pump **P** causes formation of a vacuum in the volume defined by bladder **B** and the walls of container **10**, thereby causing bladder **B** to expand into container **10** and the press against the contents of bag

17. As the vacuum is maintained, additional liquids are removed from the solids remaining in bag **17** and suctioned into tank **T**. In this way, slurry materials can be substantially de-watered, removing in some cases 98% or more of the liquids previously present in the slurry material. Tank **T** as depicted includes a drainage pipe and valve, through which tank **T** could be emptied by opening the valve or through a connection to a tank pump (not shown). It will now be appreciated that this could also be achieved with the illustrated apparatus through application of fluid pressure (water or a gas) through the valve (or a different valve) at cover **30** so as to cause bladder **B** to expand into container **10** sufficiently to contact bag **17** to encourage additional fluid to separate from the contents of bag **17**.

[0017] Typically, container **10** will be emptied by unhooking slurry pipe **15** at port **12**, then closing or tying off bag 16 (or 17) at its perimeter **18**, and closing port **12** for transportation of container **10**. To unload container **10**, a door **19** of container **10** may be opened to access and remove bag **16** (or **17**) and its contents.

[0018] The non-porous bladder employed in certain embodiments of the present invention may be formed from a variety of materials, but is typically formed from non-porous flexible sheets or film such as, e.g., the Firestone product marketed under the brand PONDGARD, or the like. The material should be sufficiently flexible to enable the bladder to expand during operation of the apparatus so as to permit an efficient vacuum to be formed in the volume formed by the container walls and the bladder, thereby enabling removal of additional liquid material from the contents of the porous bag within that volume formed by the container walls and the bladder.

[0019] The vacuum container employed in the embodiments of this invention should be sufficiently rigid to withstand the vacuum necessary to facilitate use of the system, all inlets, outlets and ports defined by the walls of the container should be equipped with fittings and seals which enable a vacuum to be maintained within the container. Conventional containers known as vacuum roll-off containers, for example, can be modified for use as the vacuum container in accordance with this invention when commercial operations call for transportation, disposal or storage of large volumes of material.

[0020] The level of vacuum to be maintained within the container will vary depending upon

the ambient pressure and temperature conditions, the nature of the material to be moved, the size of the vacuum container and related equipment and the physical characteristics of the bulk bag employed. As a non-limiting example, when employing a vacuum roll-off container of the size of about 25 cubic yards (22.86 cubic meters) and a bulk bag of the size of about 25 cubic yards (22.86 cubic meters) made from coated polypropylene sheet material, the vacuum provided to move about 20 cubic yards of slurry material into the bag, the material having an average particle size of about 3 inches or less and a weight of about 2000 pounds per cubic yard, within a period of time of about 20 minutes at room temperature and pressure, is in the range of about 10 to about 15 inches Hg.

[0021] The bulk bags employed in the systems of this invention will typically be sized in a fashion consistent with the size of the rigid container employed, but are preferably somewhat smaller than the container to avoid having excess bag material within the container which might foul the vacuum operation. Commercial vacuum roll-off containers suitable for use in the systems of this invention are typically in the range of about 25 to about 30 cubic yards (about 22.86 to about 27.43 cubic meters) in volume size. For a container of the size of 25 cubic yards, the bag will typically be in the range of about 3000 to about 5050 gallons, depending on the application. The material used to fabricate the bulk bags will depend upon the application. For applications requiring a substantially air and liquid impervious material, non-limiting examples of suitable material include coated woven polypropylene or a non-coated polyethylene film material. Such material is sold under the brand and product indentifier "PE" by the First Line Corporation of Valdosa, Georgia. For applications which require a substantially liquid permeable material for fabrication of the bag, and non-limiting example of suitable material is non-coated, woven or unwoven polypropylene. Such material is sold under the brand and product identifier "PP/Non-Coated" by the Linq Industrial Fabrics of Summerville, South Carolina. In all cases, the material thickness may vary depending upon the strength requirements for the material to be placed in the bag.

[0022] The vacuum pump employed to produce the necessary vacuum within the vacuum container may vary and could be virtually any pump capable of generating a vacuum. Commonly employed pumps will include centrifugal vacuum pumps, jet pumps, or the like. However, in preferred embodiments, the vacuum pump is one which is capable of creating a vacuum in a

substantially sealed volume without any meaningful air intake into the sealed volume. In one preferred embodiment, the pump is a jet pump substantially like that which is taught in commonly owned U.S. Patent 6,322,327, and commonly owned and co-pending U.S. Patent Application No. 10/388,780, filed on March 14, 2003. The pump described in the latter patent application, commonly known as the Pearce Closed Loop Vacuum System marketed by Pearce Pump Supply, Inc. of Prairieville, Louisiana, is particularly preferred for its ability to achieve a high vacuum and to maintain the vacuum under dry or wet conditions, its ease of maintenance as compared with conventional mechanical pumps and its ability to re-circulate the motive fluid which drives the jet pump.

[0023] Each and every patent, patent application and printed publication referred to above is incorporated herein by reference *in toto* to the fullest extent permitted as a matter of law.

[0024] It should be appreciated that, while specific embodiments are described hereinafter, several other applications of the presently described invention may be contemplated by those of skill in the art in view of this disclosure. Accordingly, the scope of this invention is not limited to the specific embodiments described in detail herein, and is instead defined by the appended claims and equivalents thereof permitted as a matter of law.